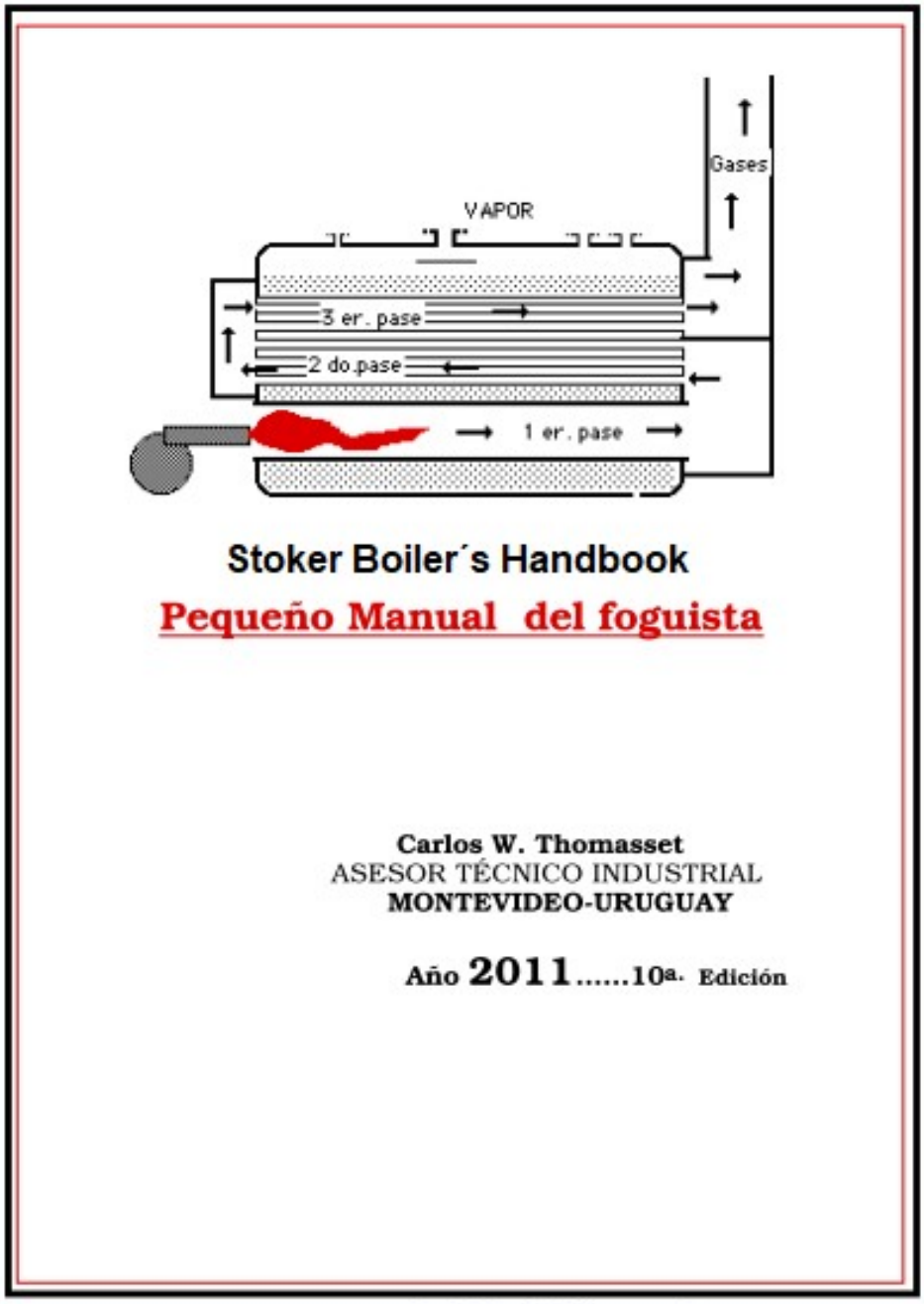
Stoker Boiler´s Handbook 2011, C.W.T. – INTRODUCTION



Today October 2025 and "Stoker Boiler´s Handbook" ("Pequeño Manual del Foguista") match 6000 views or downloads in archive.org

I think my father handbook deserve an english version translation, available to to everybody in the world. A practical handbook, boiler basic knowledge in operation to stokers and even to politechnic and academy enginners.

Pablo Juan Thomasset Trakalo, 31.10.2025

FOREWORD 1

This is a new version of the "Stoker Boiler´s Handbook" a tool developed by Carlos W. Thomasset that has been an invaluable resource for years, far exceeding its intended audience.

This Handbook possesses a rare virtue: in its theoretical foundations, while maintaining scientific rigor, it uses language understandable to all, yet upholds a level of sophistication that elevates the profession.

But what is most interesting, of immense value to both boilermakers and engineers, is the selfless transmission of practical knowledge included in this Handbook, which summarizes his life dedicated to the subject.

In every paragraph, in the advice or warning that may seem insignificant, is reflected the hard-won knowledge acquired through his extensive experience.

It is truly a reference source for everyone involved in the subject.

During my professional career in this field, there wasn't a significant problem I had to solve without discussing it with Carlos W. Thomasset and taking into account his insightful and unbiased opinions.
Because we view the profession and life with a similar ethical framework, we share a sincere friendship.

Likewise, I believe this Manual will be a friend to the reader.

Eng. Kurt Bauer, Montevideo, Uruguay, 2011

FOREWORD 2

The 10th edition, 2011, of the Little Stoker's Manual was written during the 2010-2011 oil crisis (the second oil crisis of the 21st century, following more than one crisis in the 20th century). In the previous edition (2008), we stated the same as in 2011: "This is yet another attempt to transmit practical and theoretical knowledge at a time when the price of oil is rising worldwide."

When we "burn" oil in the form of liquid fuels or natural gas to generate energy in the form of steam (both for heating products and for generating mechanical and electrical energy), we are expending chemical energy, which is the product of millions of years of accumulated solar energy in the form of biological "waste" on Earth.

Now, in just a few decades (perhaps in less than two centuries, much of which has already passed), we will consume them... It is our duty; we possess some of the knowledge, and we must be responsible, to prevent the "remnants" of this energy from being "squandered."

Humankind has not yet developed a truly "clean" energy alternative that meets all the needs of human society. Are we close or far from it? It's still unclear... In Uruguay, a country that is almost an energy desert, the only thing that has been achieved is covering a small part of its energy needs with hydroelectric dams (for electricity generation, provided it rains).

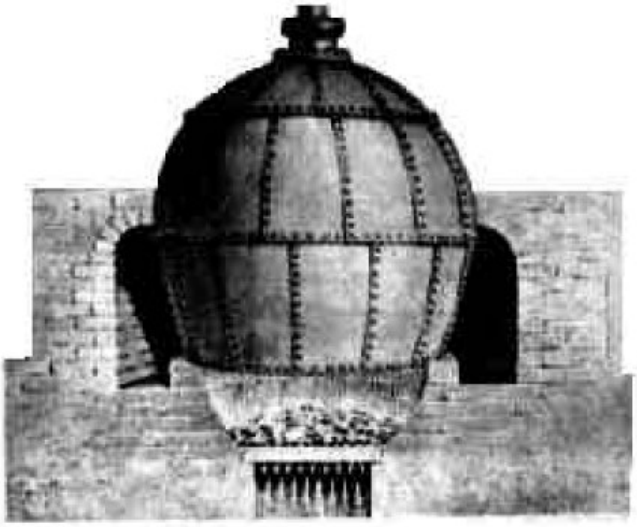
For now, another possible energy source is firewood, eucalyptus (both its specific consumption and any potential export waste), or agricultural byproducts (peels and other materials), for combustion in boilers. Other energy sources are either imported or will be a hope for the future....

This publication is not a book, it's a manual (intended as a working tool). Alternative fuels, such as firewood (eucalyptus) and other biomass, are the immediate solution for Uruguay, at least for generating steam and electricity in a combined cycle (combined generation).

Let's try to do things in the best way possible... and this is the spirit of this Little Manual. Everything we've said, we are experiencing firsthand, and we're still waiting for action. It's already 2011, and some efforts are being made to do something with biomass, wind energy, solar energy, and biofuels.

Carlos W. Thomasset, 2011

A brief history of boilers



caldera Haycock 1720

The history of boilers seems to lack a clear beginning. For many centuries, humankind has sought to harness the power of steam. Initially, this involved utilizing the properties of condensation, where atmospheric pressure actually performed the work of pressure as the steam condensed.

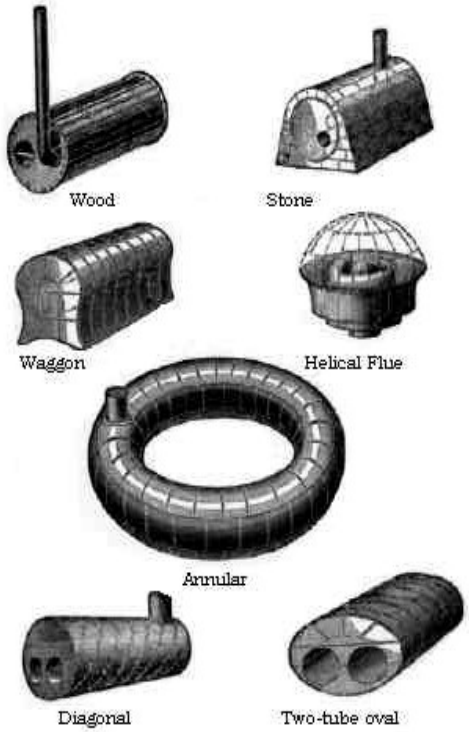
It can be said that until the end of the 18th century, boilers operated at such low pressures (barely 3 to 4 pounds per square inch, or 200-300 grams per square centimeter, or 2-3 meters of water column) that they simply displaced the air with the steam, then proceeded to cool the steam. The condensation created a "vacuum," allowing atmospheric pressure to do the work of moving a piston.

The lack of knowledge and materials was a natural limitation. Copper sheets, brass, cast iron, even wood and other materials were used in the construction. When creating the watertight seal between the plates that formed the boiler, there were so many leaks that, despite sealing it with a cardboard caulking or something similar, they then had to put elements in the water to act as "plugs" between the joints (even horse manure was put in the water!).

Let's look at a drawing of this type of boiler and even a photograph!

Fotografia tomada en 1938 caldera Haystack

This geometric shape seems quite reasonable for the time, but we'll see that there are other, more disparate shapes. There's a photograph taken in 1938 of a boiler similar to this type (found in Great Britain), which gives us an idea of what these boilers looked like. Getting to this point was quite an achievement.
Let's look at some more drawings of these early boilers from the 1700s... like the following:



Some of these low-pressure boilers, especially the last ones in the previous table, lasted until the beginning of the 20th century.

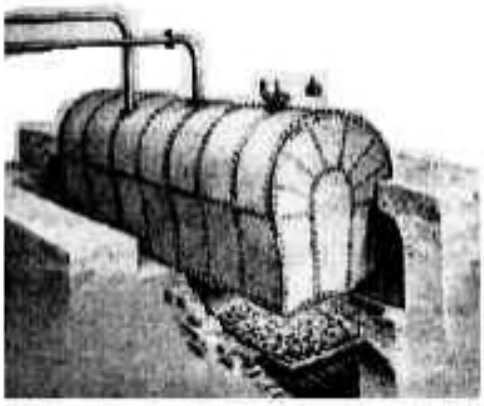
In Uruguay, at the Casablanca meatpacking plant in Paysandú, in the 1970s, they were still using Diagonal-type boilers with two combustion tubes and the combustion gas returning through the sides; burning wood, their efficiency barely reached 50%.
The risk and inefficiency (heat utilization) of these boilers, manufactured more by blacksmiths than by mechanics or specialized workshops, were so great that many people died operating them.

With the emergence of iron as sheet metal (iron foundries already existed, but "refined" iron, which could be mechanically worked, did not yet exist) in forged "plates," and with the need for operating energy in mines and factories, the first boilers with a real sense of heat utilization and with some safety features began to appear.

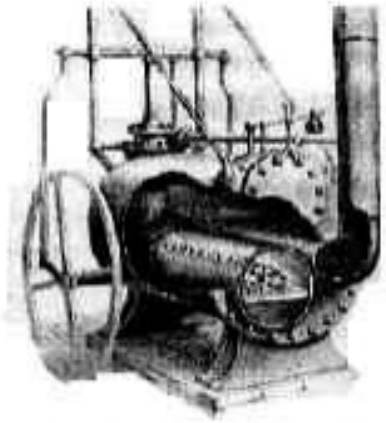
Modern boilers emerged with the dawn of the "industrial" era in European countries, especially Great Britain, Germany, and others, and in America (the United States).

The effort to convert heat energy into mechanical energy to replace the energy derived from humans, animals, wind, water, etc., was a constant objective for humankind.

First on land, particularly in mines, then in industry and railroads, in harvesters, etc., this led to the naval use of this new, usable power.
Perhaps the first fire-tube boiler based on these principles was Trevithick's in 1804.



Waggon 1768



Caldera Trevithick 1804

Comparing Mr. Trevithick's boiler of 1804 with a Waggon boiler of 1768, they are clearly worlds apart.

Improving the quality of materials, design, safety features, operation, etc., the 19th century would be the golden age of boilers, with reciprocating steam engines, as internal combustion engines would only appear at the end of the century and the beginning of the 20th.

At the end of the 19th and beginning of the 20th centuries, steam turbines would appear, powering large factories and steamships.
Among the problems with boilers in the 19th and early 20th centuries, the issue of water was very significant, as there was a great lack of knowledge about its management. Generally, the water available on site was used, which was often of the worst quality.

Little by little, the "engineers" or first "boilermen" acquired practical knowledge to improve the water's behavior in the boilers.

They used a wide variety of materials inside the boilers (from potatoes to sawdust, etc.) to prevent scale buildup. This resulted in removable sludge, which could be cleared by purging or, in many cases, by opening a lid or cap of the boiler after each shift to remove the accumulated sludge and then replacing the materials (potatoes, sawdust, etc.) before the next operation.

So many people died or were injured that, in both Great Britain and the United States, insurance companies pressured boiler manufacturers to implement improvements to prevent accidents. So much so, that even publications of that era dedicated sections to boiler accidents of the month.

In England, an insurance company had determined that in approximately 1862, a monthly report indicated that 202 boiler explosions had been recorded that month, resulting in 438 deaths and 476 serious injuries.

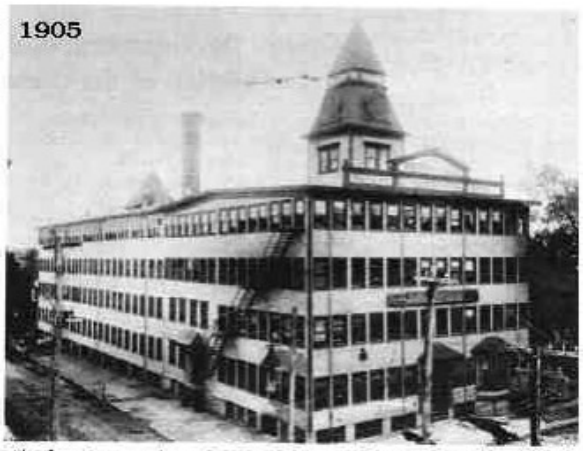
As the 19th century progressed, water-tube boilers appeared, offering greater safety as working pressure increased. They came to be called "explosive-proof."

But the entire 19th century was a true "battle" to achieve boilers with a degree of safety.

In 1866, a "Records of Boiler Explosions" report in Great Britain concluded that approximately 1,046 explosions had occurred, resulting in the deaths of 4,076 people and injuries to 2,903 (there were likely more unreported

incidents due to a lack of monitoring, reporting, or record-keeping).

In both Europe and the United States, associations of engineers, manufacturers, insurers, and others were formed. They became aware of the problem and established standards for the design, construction, operation, and inspection of boilers.



Fábrica de zapatos, de Brockton en Massachusetts, U.S.A.

For example, in the UNITED STATES, the following occurred:

It wasn't until the 1880s that ASME (American Society of Mechanical Engineers) was founded. This society of engineers would create standards for the manufacture of mechanical components, eventually leading to what would be called the Boiler & Pressure Vessel Code.

During these years, so many boiler accidents occurred that technical magazines, such as POWER MAGAZINE, had a section called:

"This Month's Accidents."

This led to boiler manufacturers meeting and creating ABMA (American Boiler Manufacturers Association) in 1888.

The combination of these associations with insurance companies (responsible for economic losses) in the event of serious disasters forced the need for these boiler codes or regulations.

One event highlighted this need.

In 1905, a shoe factory served as the catalyst for this situation of unsafe practices.

It was a "tremendous explosion" in Brockton, Massachusetts, where a shoe factory was practically destroyed, killing many people and injuring many more.

From this event onward, the idea of a code for boiler construction began to take shape, one that would include representatives from mechanical engineers, boiler manufacturers, and insurance companies.

This led to the creation in the state of Massachusetts of the first code for the construction, maintenance, and inspection of boilers with the force of law.

Then another state, Ohio, followed Massachusetts' example.

Now the conditions were right for the creation of the first national code. This took a few more years, with discussions, but in 1914, the Rules for the Construction of Stationary Boilers and for Allowable Working Pressures was created.

It was approved in 1915; it was an ASME code, in consultation with the ABMA. For it to have the force of law throughout the country, it was necessary to create what was called The American Uniform Boiler Law Society (formed in 1916).
Currently, the American code is called the ASME Boiler and Pressure Vessel Code.

Let's not forget that a simple compressed air container can be very

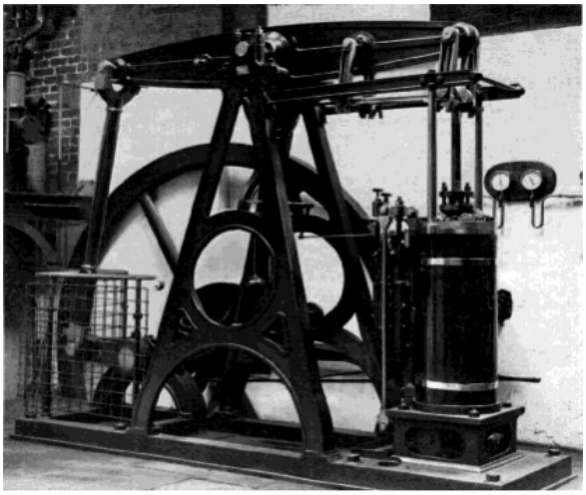
dangerous if it is not built with the appropriate materials, techniques, and designs. This applies to all fluids that can be compressed and expanded.

A very important step was selecting the inspectors for these standards. The most important thing about a standard or certification is that it is respected. That's why the National Board of Boiler and Pressure Vessel Inspectors was organized in 1919.

To this day, these inspectors are appointed through a careful selection process, drawing from a wide range of backgrounds (mechanical engineers, naval engineers, etc.). Significantly, experience in the boiler field is highly valued (both in the operation of pressure and capacity boilers, and in the length of time they have been in operation).

These inspectors act under their own responsibility once they have obtained their certification; that is, they are responsible for the certification they issue and must attend refresher courses periodically.

What must be clear is that all these codes and inspections aim to ensure that boilers and pressure vessels are safe to operate, not merely a bureaucratic formality to obtain an operating permit.



Máquina alternativa de fines de siglo 18 y principios del 19
Posiblemente construida por Boulton y Watt.

Boiler accidents still occur today.

The lack of training among people is perhaps the main cause of these accidents.

The irresponsibility of some individuals who give the false impression that

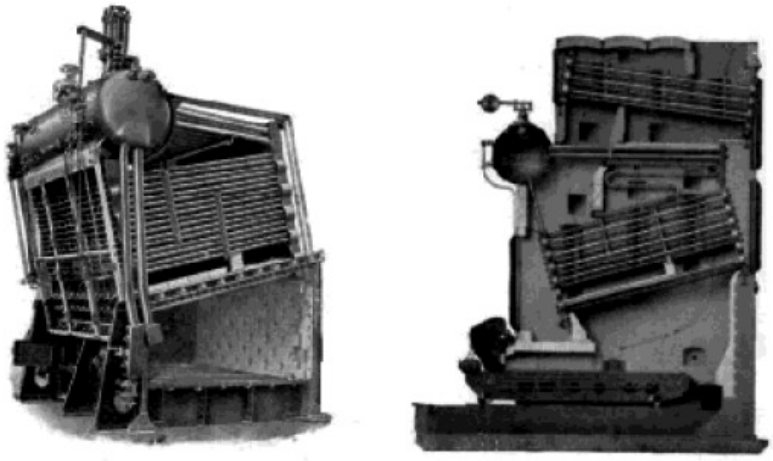
they know about the subject, some selling repairs, treatments, related equipment, or providing incorrect instruction, allows these accidents to happen when they shouldn't.

Laws and decrees in Uruguay are not very clear (there is technical confusion among those who drafted them).

Inspectors play a very important role, since generally
people think, "This boiler passed the inspection, nothing will happen to it," but if the inspector has overlooked a potential cause of a future accident, this can be very dangerous... furthermore, boilers are dynamic, and there are other possible malfunctions.

Inspectors must be very careful when giving suggestions or making demands, as a misinterpretation can lead to a situation worse than the one they were trying to correct. (It's important to remember that a boiler is a dynamic element in its operation, and only those with real experience in its construction and, especially, its operation, with many years of experience, truly understand the subject in depth. They must interpret the regulations, which are a guide but sometimes cannot solve the problem on their own.)

There may also be unscrupulous or ignorant manufacturers who sell boilers that were not built according to standards (not all standards are equally safe). This often happens with imported boilers (they come with the insulation already installed, making structural inspections difficult under those conditions; it's like a doctor examining a patient in an overcoat!).



Old water-tube boilers from the late 19th century

Therefore, when buying a new boiler, you must demand that all applicable standards are met. This includes all standards: those related to materials, construction, inspection, operation, and all safety features.

When buying a used boiler, you should find out all the historical information regarding its construction, operation, repairs, etc., and conduct an inspection with all necessary tests to ensure that the boiler is in safe operating condition.

However, no matter how good or well-built a boiler is, it must be used properly, respecting all its operating limits, because In short, any boiler can be a "bomb."

It's a mistake to think that the more pressure a boiler can withstand (the same applies to a water heater), the less risk there will be.

This is false, since what's important is the working pressure limit, as well as the heat transfer limit, etc. If these limits are exceeded, the stronger the vessel, the stronger the expansion (the expansive or explosive effect).

To this list of problems related to construction and operation, we must add an important chapter: water chemistry. In water chemistry, it is crucial to consider that it is directly linked to safety, boiler efficiency, and steam quality.

The chemicals used must be among those that do not affect human health: some products are carcinogenic, while others are not yet clearly known to be so (some of them synthetic and almost indestructible).

In a plant, the steam from these products can come into contact with humans directly or indirectly (through handling the products, the steam, etc.).

There are also "miracle" mechanical devices (generally "magnetic") that treat water.

Extreme caution must be exercised with these, as we cannot rely on something that could lead to a dangerous situation in the boiler (due to scale buildup). Significant accidents have occurred.

Stoker Boiler´s Handbook 2011, C.W.T. – INTRODUCTION

It's important to remember that the most crucial aspect of a boiler is the cooling of the metal surfaces subjected to heat transfer. These surfaces are exposed to the high temperature of combustion or its hot gases on one side, and to water or steam on the other, which cools the metal by absorbing heat.

However, a layer of scale or a surfactant phenomenon can interfere with this cooling process. These scales can burn or collapse, so ultimately, the internal circulation of water or steam in a boiler is the most important condition to consider.

FLOW LACKING COLLAPSED BOILER HEARTH

But we also have to take into account that an excessively clean boiler can be a boiler losing metal thickness (the metal in contact with the water is protected by a layer of magnetic oxide, so if this layer dissolves, the metal is attacked, losing thickness; hence, a boiler should preferably be scaled, within the limits of safety and efficiency, but its corrosion should never be allowed; corrosion cannot be fixed, controlled scaling is always cleanable).

This concept was already very clear to one of the "masters" of boilers:
The following is a copy of the book *Boilers* by Carl D. Shield, which summarizes the idea of a perfect boiler, originally presented in 1875 by Mr. Stephen Wilcox.

Note: Despite the years that have passed, this idea remains undeniably valid, but there are still those who do not apply it.

Stoker Boiler´s Handbook 2011, C.W.T. – INTRODUCTION

Mr. S. Wilcox stated in 1875:

1. Proper workmanship and simple construction, using materials that experience has shown to be the best, thus avoiding premature repairs.

2. A sludge collector to receive all the impurities deposited by the water, positioned so that it can be removed outside the action of the fire.

3. Sufficient water and steam capacity to prevent fluctuations in steam pressure and water level.

4. A sufficiently large surface area for the release of steam from the water to prevent foaming.

5. Constant and complete circulation of water within the boiler to maintain a uniform temperature throughout.

6. The water space should be divided into sections arranged so that if one of them fails, a general explosion cannot occur, but rather the destructive effects are confined to the escape of the boiler's contents.

7. Wide, unobstructed passages between Different sections, so that the water line and pressure are identical throughout the entire assembly.

8. Extremely high strength, exceeding any justifiable deformation; and a boiler construction that is free from deformations caused by uneven expansion and, as far as possible, avoids joints in parts exposed to fire.

9. A combustion chamber constructed so that the combustion of the gases, which begins in the firebox, is completed before these gases escape through the chimney. (Note: Currently, it is essential that combustion is completed virtually within the firebox.)

10. That the heating surfaces approximate a right angle to the direction of the hot gas flows, so that these flows are interrupted to extract the full heat content from the gases.

11. All parts must be easily accessible for cleaning and repairs. This is a condition of paramount importance because it relates to both safety and accessibility. Economy.

11. It must be proportionate to the work to be performed and suitable for operating at its maximum capacity with the highest economy.

12. It must be equipped with the most modern measuring instruments and safety valves, as well as other accessories.

Babcock & Wilcox Co. “Steam, Its Generation and Use”
https://ia600702.us.archive.org/4/items/steam-its-generation-use-stultz/SteamItsGenerationUseStultz.pdf

In Uruguay
The first boilers were probably those installed on ships used for long-distance and coastal shipping (both on the Río de la Plata and the Río Uruguay), in threshing machines, in some mills, and on railways.

In the case of the threshing machines, many accidents were costly due to the precarious working conditions (far from workshops, with unsuitable water, etc.).
The boilers used were of the mobile type with wheels for transport.

COAL-FIRED LOCOMOTIVE BOILER

It is a very common fire-tube boiler in Uruguay until the mid-20th century, with two tube passes and an external pass in the firebox ("hot belly"), extremely "dangerous" due to the settling of sludge on the firebox in the area of the casing, which hinders heat transfer and causes it to rupture in the fire. This type of boiler caused many accidents. They were adapted for F.Oíl.

The railways (currently AFE) were also initially powered by steam (burning wood and coal, later adapted to fuel oil).

The problem of water, which was loaded at various points throughout the country, necessitated periodic mechanical cleaning of the water chambers.

Many firemen and technicians for industry and workshops came from these railway workshops.

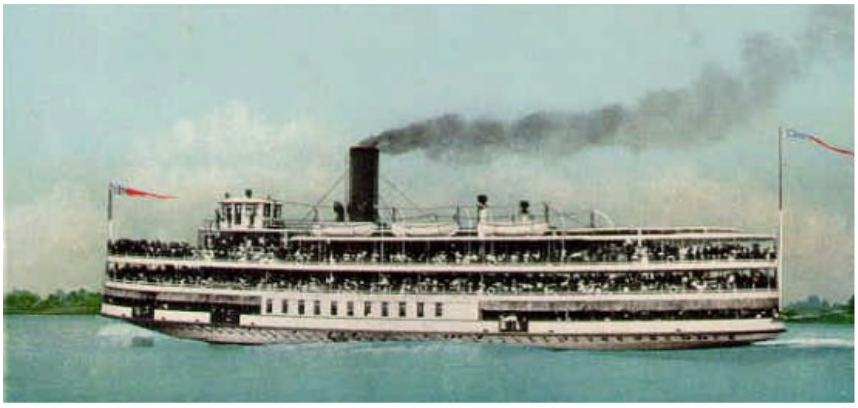
The port's winches were powered by reciprocating steam engines, fed by vertical boilers.

The state-owned electric power plant (UTE) has been and remains the main steam plant (high pressure), although in earlier times it operated smaller plants in inland cities.

The supply of drinking water to Montevideo (now OSE) was provided by boilers and reciprocating engines. The oil refinery (ANCAP) also uses energy from medium-pressure boilers with its own power generation and process gas utilization.

Some industries, such as large meatpacking plants, the textile industry, breweries, and the sugar industry, had large steam plants with turbines and their own power generation. These plants operated at medium pressure, using superheated steam.

The paper industry used medium-pressure boilers and process recovery boilers, with turbines and their own electricity generation. Some sand quarries and other extraction operations had boilers to power their machinery, now largely replaced by internal combustion engines.



Steamship from the late 19th and early 20th centuries

The ships, formerly called steamships, the very name indicating the importance of their boilers in propulsion and electricity generation. Today they have switched to diesel engines. One of the best known in recent times, the Tacoma, had low-pressure (fire-tube) boilers with steam turbines. The tankers of ANCAP (the state-owned oil company) and the Navy also used diesel engines.

The port tugboats. The "route steamships" from the last century (which connected Salto, Montevideo, and Buenos Aires) were the most famous. Many lives were lost in accidents caused by boiler failures (problems typical of that era).

The laws and decrees in Uruguay, although there may be earlier ordinances, stem from Law No. 5032 of July 21, 1914, concerning Workplace Accidents. This law was implemented over time, specifically for boilers, beginning with the law of February 7, 1925, which granted technical oversight of boilers to the Mining and Industries Inspection (later the Directorate of Industry).

Even then, annual visual and operational inspections were promoted, with more comprehensive inspections, including hydraulic testing, to be carried out every four years.

Later, by decree of December 3, 1925, three categories of boilers were established: Low pressure (up to 2 kg/cm²), Medium pressure (over 2 kg/cm² up to 4 kg/cm²), and High pressure (over 4 kg/cm²).

Today this classification has no technical meaning since the pressure limits are arbitrary, that is, everything is very relative, so today the heating surface is used which gives a clearer idea about the size of the generator.

By law of January 31, 1935, the control and collection of taxes was transferred to the Directorate of Industries.

The decrees of March 11, 1927, June 1930, May 15, 1933, November 1934, and August 31, 1938, established the framework for the General Regulations. These regulations governed all operations related to the control, transfer, and sale of steam generators.

A decree of July 24, 1933, regulated the use of welding in boiler repairs (it should be noted that boilers were generally riveted). This decree provided some very general technical standards regarding responsibilities and procedures. It stipulated that workshops performing significant repairs (such as pressure vessels) required a responsible specialized engineer.

The decree of November 29, 1940, regulated the procedures and responsibilities of boiler owners and repair shops. The owner or the shop that carried out the repair was always primarily responsible, not the inspector who certified the boiler.

The Directorate of Industries would be the supervisor, although the National Institute of Labor and Related Services would be responsible for applying sanctions.

In summary, regarding boilers, even back then:
Inspectors were required to verify the accuracy of the pressure gauge readings, using a standard gauge. Safety valves were to be sealed once calibrated (the Directorate of Industry would be responsible for verifying these seals).

The most important procedures for handling hazardous situations and the procedures to be followed during inspections were outlined.

A logbook was kept of inspections and repairs (Decree of March 11, 1927), but all breakdowns or repairs had to be reported to the Directorate of Industries (Decree of November 29, 1940).

As for the boiler operators, they were required to have a certificate of competence from the Directorate of Industries (Decree of August 3, 1945).

Decree 406/988 (Ministry of Public Health), in Chapter IV, regulates a number of elements or processes related to boilers and pressure vessels, their maintenance, and operation.
By Decree of March 12, 1997, it was agreed that the Ministry of Industry,

Energy and Mining (MIEM) could transfer the technical inspection of steam generators to the Technological Laboratory of Uruguay (L.A.T.U.).

Today, legislation is evolving, given the significant changes in steam generators (Decree 190/997 being the one that transfers the requirement for obtaining a boiler operator's license to the Technological Baccalaureate in Thermodynamics (Heating and Cooling) at the Diving Technical School). Further changes are likely in this period (2011) for various reasons.

As of January 1, 2011, in accordance with Law 18.719, the authority to regulate and oversee the operation and safety conditions of steam generators was transferred from the National Directorate of Energy and Nuclear Technology (DNETN) of the Ministry of Industry, Energy and Mining (MIEM) to the Regulatory Unit for Energy and Water Services (URSEA).

However, some valuable aspects of these previous laws and decrees, some of which are no longer in use, remain. For example, one requirement was for each generator to centralize all information throughout its useful life in a logbook on-site (this serves as a record, which is very important).

Another requirement was the on-site inspection of pressure gauges, since even a calibrated and sealed pressure gauge can malfunction between the calibration and sealing location and its installation on the boiler.

I disagree with the regulation regarding the daily purging of the pressure gauge connection (this causes corrosion and fatigue in the gauge). Perhaps the reason for this requirement was the fear that the gauge was seized (a very likely scenario in those times when water treatment was practically nonexistent).

I believe that dynamic pressure testing of the opening and closing (using the boiler's own pressure) of the safety valves is a good thing; it's the only way to ensure they operate correctly, and they should be sealed by the inspector.

However, capacity tests should also be performed (something I've never seen done in 45 years), especially on new boilers. The pressure gauge should also be checked using a standard gauge (under the inspector's responsibility).

Since a supposedly "certified" pressure gauge can be damaged during transport between certification and its place of use (a situation easily controlled with calibration using a standard pressure gauge, specifically designed for this purpose and subject to frequent checks, as pressure gauge valves have a plate for connecting the standard gauge without needing to

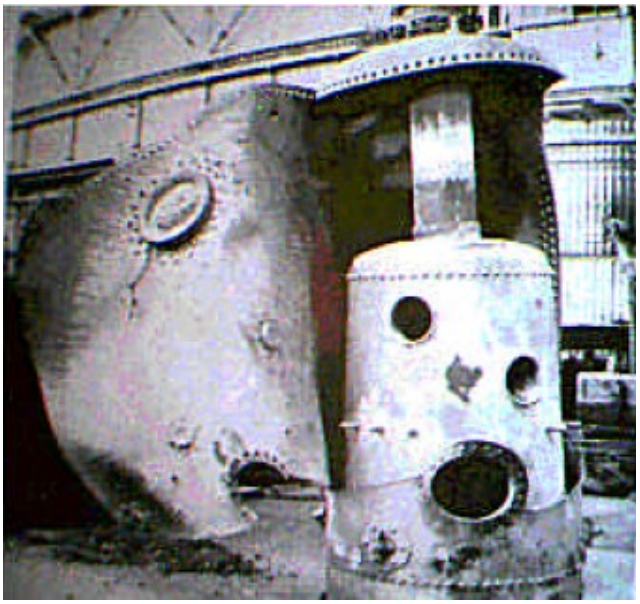
disconnect the installed gauge; see the corresponding chapter). This was already regulated.

It is good safety practice to test boiler casings not only against failures but also due to the effects of time: such as the 25-year test, in which all insulation must be removed and a thorough inspection of the pressure vessel must be carried out (thickness, weld inspection using non-destructive testing methods, etc.).

But what remains crucial is the observation of the entire boiler casing and the checks carried out in the logical locations where corrosion, fatigue, or wear problems might occur (these points are generally in hard-to-reach areas).

Hence the importance of the inspector's or company advisor's expertise, since simple measurements and tests are often insufficient to truly assess the "questionable" safety condition of the boiler.

We have decommissioned boilers that were declared "in good condition" by companies specializing in casing measurement and inspection (since visual inspection reveals things that only "experience" shows). Because there is no more serious accident than a casing that cannot withstand the pressure and ruptures in an explosion!



OLD VERTICAL BOILER.
This boiler has suffered a casing explosion, the most dangerous type of accident, generally caused by structural failures, caustic attack on the rivets, or simply excessive pressure.

In this past year (2011), legislation continues to evolve, but some questions remain:

Stoker Boiler´s Handbook 2011, C.W.T. – INTRODUCTION

What are boilers today?

a- A pressure vessel (as was the case until the mid-20th century)

b- A set of mechanical, electrical, electronic, and chemical engineering components (a product of the need for automation and the high efficiencies that are sought, with very high vaporization rates per square meter of surface area).

In my opinion, boilers are no longer simply a "pressure vessel" (as they were more than 50 years ago). Back then, boilers not only had construction problems (materials and procedures, tools like welding, etc.), and their low vaporization rates per square meter and lack of automation were problematic; the pressure vessel itself was the main issue.

Today, high automation and high specific vaporization make the pressure vessel as important as the automation (electrical and electronic), or perhaps the internal circulation (which is the most important, depending on the design and chemical treatment), or the chemical treatment, which influences both heat transfer and internal circulation (since high vaporization does not tolerate scaling, corrosion, carryover, etc., or the simple physicochemical alteration of the water under the conditions it is subjected to inside the boiler).

So the big question is: who are the professionals exclusively trained in "boiler knowledge"?

In answering this question, I believe there isn't a specific profession, but rather a "suitability" with a university or technical foundation (whether they are mechanical, industrial, naval, electrical, electronic, or chemical engineers, or technologists from related fields).

And evidently, in each section, there will be some whose backgrounds facilitate their understanding, and therefore, on specific and high-risk topics, they will have the floor. However, they must not forget that there is no limit to the scope of each topic, preventing it from being isolated from the others.

For an excellent boiler as a pressure vessel is useless if its internal circulation is poorly designed, or if the (automatic) safety elements are inadequate or not properly adjusted, or if the chemical treatment is simply not appropriate for the circumstances.

Now you are the protagonist; let's delve into the topic on the following pages...

Definitions of a steam boiler:

Steam boiler: A vessel where water boils, the steam from which is used as the motive force of a machine. -- Sopena Universal Encyclopedia. --
A steam boiler is a closed vessel designed to produce steam at pressures above atmospheric pressure, using the heat generated by burning a solid, liquid, or gaseous fuel. -- "Marine Boilers" by Moisés Romero Villanueva. --

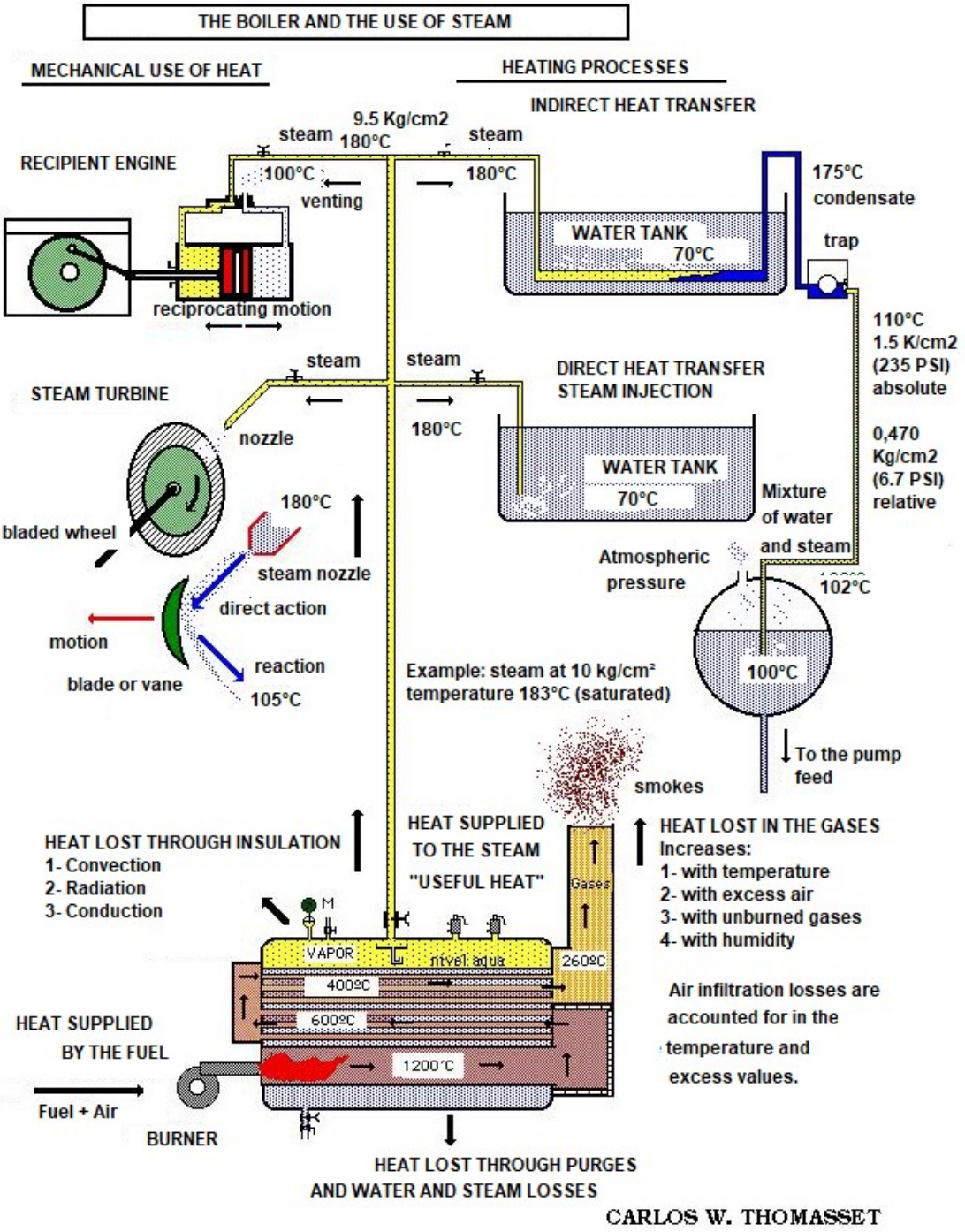
A boiler is defined as: a closed vessel in which water is heated, steam is generated, steam is superheated, or a combination of both, under pressure or vacuum with the direct application of heat.

The term boiler may also include combustion units for heating or vaporizing liquids other than water; these are closed systems within themselves. -- The American Society of Mechanical Engineers. --

In this short manual, we will refer to a steam boiler and define it as follows:
A closed vessel for the production of steam:
for the transfer of heat or its transformation into motive power, heated directly by the combustion of a liquid, gaseous, or solid element in contact with air.
Equipped with devices for the control and safety of its operation.

For the purposes of this short manual, we exclude: electrically heated boilers, thermal fluid boilers, heat recovery boilers, furnaces, etc., although there may be elements discussed here that are associated with them.

The previous definition tells us that a boiler is a device that transforms the "chemical heat" that is latent in a fuel and that, when "burned" in the air (combustion), releases heat that is transported through the metal wall of a container holding water. This water, upon absorbing the heat, increases its temperature (sensible heat) until it evaporates (latent heat), and this heat is then transported in the steam until it is used as heat (process heating) or work (reciprocating steam engine, steam turbines, etc.).



As we can see, a number of elements come into play for the operation of a boiler.

To understand and operate a boiler correctly and efficiently, it is necessary to know these elements and how they work.

1- The Basic Boiler
2- Water and Steam
3- Fuels
4- Boiler Components
5- Operation
6- Emergencies
7- Maintenance
8- Steam Installation
9- Boiler Efficiency
10- Electrical Controls
11- Structural Failures
12- Safety Valves
13- Packings and Gaskets
14- Drying Firewood
15- The Superheater
16- Heat Recovery Units
17- Preparing Boiler Water
18- Boiler Water Monitoring
19- Boiler Blowdown
20- Chemical Cleaning
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